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Aesthetic perceptions of a shrinking glacier: evidence from the Mont Blanc massif

Emmanuel Salim*¹; Ludovic Ravanel^{1,2}; Christophe Gauchon¹

*emmanuel.salim@univ-smb.fr

¹University Savoie-Mont-Blanc, CNRS, Edytem, 5 Bd de la Mer Caspienne, 73376, Le Bourget-du-Lac, France

²University of Lausanne, CIRM, 1967 Bramois, Switzerland

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Abstract

Glacier landscapes attract millions of tourists every year; however, climate change induces alterations in these popular destinations. Although landscape changes can affect visitor behaviour, very few studies have investigated their impact on tourism. This study investigated how recent changes in the most-visited French glacier, the Mer de Glace (Chamonix, Mont Blanc massif), influenced tourist judgments and dissatisfaction. The methodology comprised a qualitative analysis, which was performed by interviewing tourists, supported by a quantitative survey. Despite the landscape being severely affected by climate change, the results revealed that the visitor's dissatisfaction level remained low. Nonetheless, the glacier is negatively perceived owing to changes in length, colour, and size. In addition, factors such as the glacier tongue covered by debris, lack of snow, dryness, desolation, and 'degraded nature' have adversely impacted the landscape's aesthetics. A linear regression analysis demonstrated that tourists' motivation to visit, estimation of the retreat rate of Mer de Glace, and living in France or abroad significantly predicted landscape dissatisfaction. Moreover, the results revealed that up to 30.2% of the respondents might not visit the site if glacier visibility was hindered, which is the likely situation within the next 30 years. Consequently, solutions that tourism operators can implement include reorganising marketing resources and focusing on the glacier as a resource for climate-change interpretation.

Keywords: glacier tourism; scenic landscape; climate change; aesthetic perception; Mer de Glace; last chance tourism

1. Introduction

Glacier tourism is niche tourism that is currently significantly impacted by the effects of climate change (Wang & Zhou, 2019). Alpine glaciers are experiencing rapid melting due to increasing temperatures that may lead, in the worst scenario of the IPCC (RCP 8.5; IPCC, 2014), to the disappearance of 99% of the glaciers located in World Heritage sites before 2100 in Central Europe (Bosson et al., 2019). This phenomenon impacts glacier tourism by hindering access to glaciers (Purdie, 2013; Stewart et al., 2016; Mourey & Ravanel, 2017), increasing rockfall-related hazards and problems for ice-hiking groups (Purdie et al., 2015), altering alpinism routes (Mourey et al., 2019), and causing the occasional disappearance of the glacier (Kaenzig et al., 2016). Other phenomena related to glacier shrinkage that occur outside the glaciated area, i.e. paraglacial activity (Ballantyne, 2002), have also emerged; these include landslides and infrastructure destabilisations (Duvillard et al., 2018; Kos et al., 2016). Glacier tourism operators are adapting their activities to these changes by altering access to the glacier, changing their activities temporally and spatially, enhancing tourism planning and education, and implementing methods to slow glacier shrinkage (Salim et al., 2021). As glaciers recede, the landscape aesthetic is threatened (Diolaiuti & Smiraglia, 2010), especially when glacier tongues are covered with debris. However, despite the aesthetic value being preeminent in glacier tourism (Welling et al., 2015), few studies have focused on the impacts of the aesthetic changes on tourist perception and behaviour. To ensure the sustainability of glacier destinations, tour operators need to understand how visitors' experiences are influenced by climate change.

In this context, understanding tourists' judgements of the changing landscape will help tourism stakeholders adopt effective adaptation strategies (Pröbstl-Haider et al., 2016). Accordingly, this study investigated the obvious impacts of climate change and glacier retreat and their influence on tourists' judgements of the landscape. Furthermore, the study aimed to explore the relationship

between tourist sociodemographic and trip characteristics and visitor satisfaction with the glacier landscapes they saw.

2. Literature review

2.1 Landscape theory

The term ‘landscape’ appeared around 1600 CE and is defined as a familiar place that is practised and lived in by a local population (Olwig, 1996). However, according to Jacobsen (2007), it is currently understood as ‘scenery’. A commonly used definition of landscape provided by the European Landscape Convention states that a landscape is ‘an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors’ (Council of Europe, 2017; p. 25). The understanding of the term “landscape” depends on the epistemological paradigm through which it is explored. For essentialists, things contain intrinsic qualities that constitute their essence, and the ‘landscape’ is, therefore, a thing ‘in itself’ (Chilla et al., 2015). For positivists, the landscape is an observable object that can be analysed through measurements (Kühne, 2019). For constructivists, a landscape is no longer an essence or physical object to be considered but a product of how it is individually and socially constructed (Kühne, 2019).

Landscapes have been studied since the mid-1970s (Ulrich, 1977). Two major paradigms are used to measure the public aesthetic perception of a landscape (Lothian, 1999): the physical paradigm that assumes that the physical properties of a landscape can determine its aesthetic quality and the subjectivist paradigm that assumes that the quality of a landscape depends on the ‘eyes of the beholder’. Researchers have highlighted that viewers prefer the natural features of a landscape to the anthropogenic ones (e.g., Purcell et al., 1994; Zube et al., 1982). However, the subjectivist paradigm seems to prevail in research (Daniel, 2001).

Research in the subjectivist paradigm has applied four different approaches: expert, psychophysical, cognitive, and experiential (Jacobsen, 2007). According to Zube et al. (1982), the

‘expert’ approach assumes that landscape aesthetic evaluation entails skilled and trained observers. The ‘psychophysical’ approach assesses the landscape aesthetic through the public. In this approach, aesthetic judgement is derived from the relationship between the landscape and the observer and is relative to both the observer and physical components (Zube et al., 1982). The ‘cognitive’ approach assumes that the aesthetic judgement of a landscape is derived from the observer’s past experiences, sociocultural conditioning, or expectations. Finally, the ‘experiential’ approach considers the ‘landscape values to be based on the experience of the human–landscape interaction, whereby both are shaping and being shaped in the interactive process’ (Zube et al., 1982; p. 8). Studies conducted using expert and psychophysical approaches generally focus on how meaningful or beautiful such landscapes are. Investigations carried out using cognitive and experiential approaches are mainly concerned with theoretical issues surrounding the landscape characteristics, preferences, and meanings that people attach to particular landscapes (Jacobsen, 2007).

Bourassa (1991) classified landscape preferences as the result of a combination of biological and cultural determinants. More recently, Hunziker et al. (2007) established that landscape could be understood in two modes: space and place. Space-focused research deals with biological inheritance; the savannah theory is an example related to this (Orians, 1980). In contrast, place-focused research deals with sociocultural backgrounds using concepts like ‘sense of place’ (Hunziker et al., 2007). Sense of place refers to emotional bonds between a place and an individual (Raymond et al., 2010). A place has a symbolic meaning related to the attributes that an individual places on a location (Stedman, 2016). Place identity refers to self-identity reflected by the environment (Hunziker et al., 2007). Place dependence refers to how a place provides the opportunity for goal achievement (Jorgensen & Stedman, 2001). These concepts are essential for researching landscape preferences (Hunziker et al., 2007).

As 90% of human perception is visual (Porteous, 1990), the scenic landscape is a central element in tourism. The landscape is considered to be the first medium of contact between places and

tourists (Terkenli, 2008), and tourists often use aesthetic dimensions to choose a destination (Vogt et al., 1994). Moreover, the aesthetic quality of a destination influences overall satisfaction and revisit intentions (Lee et al., 2011). Howard & Sheth (1969) defined satisfaction as the relationship between aspiration and perceived experience, and Oliver (1980) proposed the expectancy-disconfirmation paradigm to describe the process. This paradigm consists of four elements: expectations, perceived performance, disconfirmations, and satisfactions. If the perceived performance is lower than the expectations, there is negative disconfirmation that leads to dissatisfaction. If the perceived performance is higher than the expectations, there is a positive disconfirmation that leads to satisfaction. If the perceived performance is equal to expectations, there is confirmation (or zero disconfirmation) that leads to neither satisfaction nor dissatisfaction (Weiss et al., 2004). Despite its popularity, this model has been criticised in the literature (e.g. Huang et al., 2014; Koenig-Lewis & Palmer, 2014; Ozdemir et al., 2012) because its degree of standardisation is doubtful and the effects of pre-trip expectations on satisfaction are not always as significant as expected. However, other studies show that expectations have an impact on satisfaction (Fu et al., 2018), especially for places that have received substantial media coverage (Carl et al., 2007), such as Montserrat-Mer de Glace (Salim & Ravanel, 2020). Studies reveal that motivations (Huang et al., 2014) and sociodemographic factors (Ma et al., 2018) can influence satisfaction. Furthermore, as nature connectedness (Nisbet et al., 2009) and perception of climate change are correlated with motivations (Salim & Ravanel, 2020), it is possible that these variables also have a relationship with satisfaction. Carlson (2007) developed the theory of Cognitive Aesthetics, which proposes that aesthetic judgement can be correlated to the subject's knowledge of the object seen.

As several tourist destinations worldwide are experiencing landscape changes due to climate change (Nyaupane & Chhetri, 2009; Scott et al., 2012), studies on tourists' reactions to changing landscapes are crucial in helping tour operators make decisions. In particular, the impact of glacier retreat on satisfaction and aesthetic judgement appears to be significant and under-studied.

2.2 Glacier tourists' perceptions of glacier retreat

Several studies have demonstrated the significance of landscape in glacier tourism. In Yulong Snow Mountain (China), Yuan et al. (2006) showed that only 15.5% of the respondents stated that the glacier was insignificant in their decision to visit the place, and therefore, the authors suggested that tourism in the region could decrease by 19–43% in the case of glacier disappearance. Tourism is also declining in Norway, where commercial glacier activity has reduced by 30% between 2003 and 2009 (Furunes & Mykletun, 2012). More recently, Stewart et al. (2016) showed that 46% of the tourists at Franz Josef and Fox glaciers (New Zealand) would not visit the region if there was no opportunity to view the glacier. Concerning glacier tourism in Iceland, Welling et al. (2020) have shown that the willingness of tourists to revisit the glacier is likely to be reduced if motorised transport is required. Weber et al. (2019) present four adaptation scenarios for the Athabasca glacier (Alberta, Canada) and indicate that the scenario with high ecological integrity (limiting infrastructure development) is rated significantly higher, in terms of tourist satisfaction, than scenarios with low ecological integrity. These results highlight the importance of naturalness for glacier tourism that is revealed in a large number of publications on the motivation of tourists to visit glaciers (e.g., Stewart et al., 2016; Lemieux et al., 2018; Purdie et al., 2020; Salim & Ravanel, 2020).

Some researchers have addressed tourists' perceptions of landscape changes. Moreau (2010) conducted a study at the Évettes glacier (French Alps) and showed that the glaciers are considered the most characteristic element of high-mountain landscapes, and glacier retreat is the most important recent change in tourists' perceptions. However, proglacial landforms are poorly understood by tourists at the Évettes glacier and 50% of the respondents consider those areas as currently inaesthetic. In the Italian Alps, Garavaglia et al. (2012) show that tourists around the Forni glacier perceived evident changes in the landscape but were unable to quantify them. Stewart et al. (2016) studied glacier tourism in New Zealand and presented the glacier changes respondents observed, which included the glacier becoming “dirtier” and expecting the glacier to be larger.

Moreau (2010) reported that tourists do not understand the complex dynamics of the glacial and proglacial landscapes, which in turn led Garavaglia et al. (2012) to recommend more *in situ* materials for interpretation. When Groulx et al. (2016) surveyed tourists at the Athabasca glacier, they used constructed photographs of the future landscape based on environmental changes and tour operator adaptations. The results showed that the tourists preferred the present landscape. Adaptations proposed by tourism operators, including infrastructure expansion, led to a decrease in tourists' willingness to return to the Athabasca glacier, suggesting that tourists significantly value the 'naturalness' of the landscape. Weber et al. (2019) supported this by establishing that ecological integrity is important for the tourists at the Athabasca glacier. More recently, Welling et al. (2020) showed that 46.7% of 556 respondents would not visit the Iceland glacier if it were 'considerably covered by sand, mud, and stones'. In addition, the public's perception of glacier retreat has developed last chance tourism (LCT), which is based on visiting an endangered natural feature 'before it disappears, vanishes or is irrevocably transformed' (Lemelin et al., 2010; p. 488). Many research studies have shown that this phenomenon is relevant to glacier tourism (Lemieux et al., 2018; Salim et al., 2021; Salim & Ravanel, 2020; Stewart et al., 2016), but its implication for landscape satisfaction has not been examined. He & Hinch (2021) showed that implementing climate change education elements had a relatively positive influence on tourists' overall satisfaction.

Based on past research, this study focused on a glacial landscape where the marks of climate change (i.e. destabilised moraines and debris-covered glacier tongue) are clearly visible and investigated landscape dissatisfaction and the aesthetic judgements of tourists. Three research questions are addressed: i) Which elements of the glacial landscape perceived by tourists guide their judgements? ii) Do tourists' characteristics influence their landscape dissatisfaction when visiting the sites? iii) Does landscape evolution driven by climate change reduce the attractiveness of glacier tourist places?

3. Material and Methods

3.1 Study site

Located on the border between France, Italy, and Switzerland, Chamonix registered 7.7 million tourist nights during 2019, and 51.3% were during the summer season (G2A consulting, 2019). The Montanvers-Mer-de-Glace became the first glacier tourist site in France in 1741 (Joutard, 1986). Today, it consists of a viewpoint (1913 m a.s.l.), where tourists can enjoy a view of the glacier tongue and surrounding peaks (Figure 1a). They can take a cable car to visit an ice cave (Figure 1d), patronise a restaurant, and visit a glacier interpretation centre (Figure 1b). The site is reachable by a rack railway throughout the year, but 75% of the tourists visit in summer.

The Mer de Glace ('Sea of Ice') is the third-largest glacier in the Alps but has dramatically retreated during the last decades; it has lost 1.5 km in length and 32% of its thickness downstream toward Montanvers since 1900 (Vincent et al., 2019). These changes have altered the landscape by decreasing glacier volume and increasing debris on the glacier tongue (Figure 2). Changes are expected to continue and increase, and the glacier may not be visible from the Montanvers viewpoint by 2070 (Peyaud et al., 2020).

3.2 Mixed method

This research uses a concurrent strategy that enables qualitative data to be supplemented by a quantitative survey conducted simultaneously. The results were analysed independently and then compared (Creswell, 2009). In this study, this strategy allows for a qualitative investigation of the judgements of the glacial landscape observed during the interview to be supplemented by a quantitative survey to measure the variables that influence dissatisfaction with the landscape. From a pragmatic perspective, this approach expands the data collected to answer the research questions (Creswell, 2009). These two methods were simultaneously implemented during summer and winter 2019. At the main viewpoint in Montanvers, tourists were approached during the operating hours of

9 am to 5 pm and were invited to be surveyed or interviewed after a brief explanation about the purpose of the study. When we met a group, each member had a chance to participate in the quantitative part and only one member in the qualitative part. In this case, one person from the group was asked for consent to be interviewed. Thus, this is an opportunity sample with the person who has given acceptance. To ensure response diversity, the respondents of one method were excluded from the other. One researcher conducted all the qualitative interviews, which were anonymously recorded with the permission of the respondents. The quantitative survey was conducted using tablet computers by one researcher during summer and by a team of eight researchers during winter due to time constraints.

3.3 Qualitative interviews

The qualitative method comprised 32 semi-structured interview questions, and each interview lasted for 20 to 30 min. We chose semi-structured interviews because they provide a degree of freedom to the respondents' while being sufficiently structured to remain focused on a specific topic (Galletta, 2013). The interview guide (Appendix 1) consisted of 27 questions that provided an understanding of the perceptions of the respondents and their appreciation of the landscape.

All the interviews were transcribed and coded using direct content analysis (Hsieh & Shannon, 2005) and MAXQDA (Saillard, 2011) and an interpretation derived from the grounded theory (Charmaz & Belgrave, 2012) was applied. Initially, coding was used to classify respondents' judgements into two categories: positive and negative. A judgement is considered positive or negative when the respondent describes elements or ideas about the landscape that satisfy or dissatisfy them. Each judgement was then coded inductively to reflect the respondents' statement by limiting their abstraction (Charmaz, 2006). This step produced 40 and 22 codes for positive and negative judgements, respectively. The codes of each group were then analysed for similarities and grouped into more abstract categories that resulted in 9 and 8 categories of positive and negative

judgements, respectively. Next, the corpus of interviews was recoded to reveal the primary emotions expressed by the respondents.

3.4 Quantitative survey

The survey used by Salim & Ravel (2020) to identify tourist motivations and explore issues related to LCT was reused, and certain variables to test visitor disconfirmation regarding the landscape were adopted. The questionnaire (Appendix 2) has six parts: trip information, motivations, nature connectedness, climate change perception, landscape judgements, and sociodemographic characteristics. The motivation part includes 20 Likert-scale items (1 = not important at all; 5 = very important) derived from the recreation experience preference scale from Manfredo et al. (1996) and other studies concerning LCT (Lemieux et al., 2018; Stewart et al., 2016). The nature connectedness part was based on the nature relatedness scale (NR-S) provided by Nisbet et al. (2009). The landscape judgement part was based on two Likert-scale questions related to landscape expectation (*'Does the beauty of the landscape meet your expectations?'* 1= No; 4 = Yes) and a question on perceived changes since the last visit. Based on the expectation-disconfirmation paradigm, the first of these two questions measures whether the observed landscape is a source of dissatisfaction. If the answer to this question is 4 (yes), then there is neither dissatisfaction nor satisfaction. From 3 to 1, there is a negative disconfirmation and consequently a more or less strong dissatisfaction. However, this method did not show whether the observed landscape exceeded the expectations and was therefore a source of satisfaction (Weiss et al., 2004). A preliminary survey was conducted in June 2019 (n = 10), and it led to the revision of the survey; three questions related to motivation that were not initially expected were added and a question that caused a misunderstanding was deleted from the NR-S.. The final survey had 54 questions, was presented in French and English, and took an average of six minutes to complete. The sample contained 447 completed surveys, of which 13 were removed as they were incomplete or were responses from persons under 18 years of age.

Consequently, the analysis had a sample size of 434. Quantitative data were analysed using SPSS v.26 (Cronk, 2019) and SphinxIQ2 (Ganassali, 2014).

Exploratory factor analysis was conducted by Salim & Ravanel (2020), which identified five factors for LCT (seeing the glacier or the landscape before its disappearance), learning (discovering new things), environment (seeing the landscape, being close to nature), storytelling (desire to let other people know that you visited this place and have a story to tell), and tranquillity (desire for calmness and solitude). In this paper, motivational factors and tourist characteristics were variables tested to see if they could explain landscape dissatisfaction. Statistics were reported to describe the frequency of items related to landscape judgement. Linear regression analysis was used to explain landscape dissatisfaction. For this study, the above technique enabled the explanation of an independent variable (*‘Does the landscape meet your expectation?’*) in relation to a set of predictor variables (Montgomery et al., 2021). Motivation factors and perception of climate change and nature connectedness were included in the analysis. Other variables related to tourist characteristics were added (i.e., first-time tourist, age, domestic or international). Three variables measuring mountain experience were added (i.e. regular visit to the mountains; retreat rate of the glacier; hiking and mountaineering practice). Finally, a variable concerning the willingness to come to the site even if there was no glacier to see was added.

4. Results

4.1 Qualitative results

Among the 32 interviewees, 15 were female and 17 were male, with an average age of 47 years (range 22–70 years), 7 (21%) were foreigners and 25 (79%) were French. First-time tourists represented 23 (72%) respondents. During the interviews, 30 of the 32 respondents (94%) had at least one positive judgement on the landscape, and 25 of 32 (78%) expressed at least one negative judgement.

The initial codes created from the interview transcripts were categorised, and the summary of these codes is presented in Table 1. In the following sections, we outline the categories based on positive or negative judgement. We considered a positive judgement of a landscape element to contribute to the overall satisfaction of the site and a negative judgement to contribute to dissatisfaction. The elaboration of the grounded theory will be carried out and analysed regarding the quantitative results in the discussion section.

4.1.1 Positive judgements

The first category of the positive judgement is related to the notion of ‘sublime’. It includes codes related to distances between objects (mountains) and their heights, being ‘magnetic’ (attractive to the eye), or the ‘gigantic’ character of the landscape. Here, the sublime also includes the notion of ‘multiple landscapes,’ i.e. a strong perception of the variety of elements presents in the landscape and the notion of magnificence.

The second category is related to the concept of naturalness, which is understood as a landscape expressing ‘nature.’ It includes codes such as an environment protecting a ‘well-made nature.’ This category also includes a more concrete code related to vegetation. Finally, some respondents consider that landscape refers to the idea of a ‘garden.’ The third positive category identified is the feeling of humility the landscape evokes. Although linked to the idea of the sublime, this feeling of being ‘nothing compared to the contemplated landscape,’ ‘small compared to nature,’ signify humility, and it also includes codes reflecting ‘scale.’

Hedonism is the fourth category; it is related to codes such as wellbeing and happiness and ideas about accessing landscape, calm, serenity, and enchantment. The category of reflexivity relates to respondents who believe that landscape leads to reflection and consider this reflection positive. It includes the idea of mystery, and respondents consider the way that the landscape experiences climate change; however, this is not perceived as negative but as a way for individuals to rethink their roles. Finally, some respondents consider the landscape to reflect the history of the planet.

The change category reflects the changes in the glacier. These changes can be viewed positively as they provide information about the landscape; some tourists were interested in the evolution of the glacier between visits, causing them to be positively impressed.

The seventh category corresponds to wilderness. It includes concepts such as the idea that the landscape represents ‘the power of the elements,’ ‘danger,’ or that the landscape provides ‘thrills.’ This category also includes more concrete notions related to the contrasts in the landscape or the steepness of the mountain faces.

The eighth category encompasses rarity. Many tourists considered it uncommon to see these landscapes, witnessed them for the first time, or had waited a long time to visit; they were thus rewarded for their wait.

Finally, the ninth and last category of positive judgements relates to the sense of identity. It is related to either a local or regional scale, where tourists living close to the place are ‘proud’ and consider that this landscape is their home. Others consider the landscape to be national and emblematic and consider that they belong to the nation and are characteristically French.

A summary of the positive categories and the quotes associated with each of them are provided in Table 2.

4.1.2 Negative judgements

The categories related to negative judgement were overwhelmingly related to the glacier. All 25 interviewees who expressed negative judgements about the landscape described glacier changes. The foremost glacier change mentioned was the loss of volume and its importance in the landscape compared to the tourist’s memories, i.e. it was often much greater in memory than in reality. Glacier retreat is perceived as creating a gap in what is observed and causes an aesthetic depreciation.

Extending debris cover is the second category, and respondents had expected the glacier to be whiter. In their imagination, the ice was bluish, turquoise, or translucent, and the greyish appearance of the glacier is negatively perceived. Comments expressed included ‘stony,’ ‘grey,’ or ‘sandy’

landscape, 'it looks like a working site,' 'it made me think about the construction of the Suez Canal,' or 'I feel like it has been scraped by machines.' The presence of rock and sand lead to the perception of a 'dirty glacier.'

The lack of snow and therefore the lack of 'white' at the surface and around the glacier, which is considered to be a part of the high-mountain landscape, leads to the third category termed 'drought.' In addition to snow issues, it includes the idea of a dry landscape, which is perceived negatively.

These elements lead to an experience of feeling 'desolated' and consider the landscape to be 'chaotic.' This category also contains the idea that this landscape has been 'impacted,' i.e. 'it is not what it should be.'

The next category relates to the idea of 'nature degradation,' specifically by humans. A tourist mentioned: 'It's just not natural anymore; it is as if we saw the human footprint that has disfigured the landscape.' Anthropisation, perceived as ontologically destructive, hinders the imagination of a utopian 'natural nature' and leads to a negative judgement of the landscape. Moreover, this landscape, on a temporal scale, is considered to be permanently decomposing or degrading. This category also contains the idea of a lifeless and disfigured landscape witnessing disruption.

As with positive judgements, a category related to reflexivity is present. It relates to the landscape being perceived as representing climate change and revealing a problem. Finally, for some respondents, it implies a fear about the future.

The sense of identity is also factored in, expressed as an idea of the loss of an emblematic object (the glacier). This category also refers to memories of past experiences such as the practice of mountaineering or ski touring and that the landscape indicates these practices might soon disappear. Finally, the last category relates to a loss of attractiveness of the site due to these changes. Table 3 provides a summary of the negative categories.

4.1.3 Common categories

Although many categories appeared only in the positive or negative judgements, four categories appeared in both: changes/glacier changes; identity; naturalness/nature degradation; reflexivity.

The first common category concerns changes. For negative judgements, shrinkage of the glacier was considered. For positive judgements, glacier changes were also perceived, but were judged positively because they contain an informative dimension. The current retreat was judged negatively, but the information about what this retreat implies was judged positively.

The second common category relates to the question of nature. In the case of positive judgements, the landscapes were considered 'natural,' which was judged positively. Contrastingly, the degradation of this 'nature' was judged negatively. The difference between these two categories seems to lie in whether respondents 'see' the consequences of climate change in the landscape.

Two other common categories of identity and reflexivity also were linked to the perception of climate change. In the case of identity, negative judgements occur when the respondents consider the observed elements to be threatened by climate change. In the case of reflexivity, climate change also leads to negative judgements. However, the dichotomy is less significant here because climate change is also judged positively in terms of the reflexivity it induces.

Judgements also seem to be related to the primarily observed object. For all these categories, we tried to identify the main object that leads to the code (e.g. the glacier, the summits, or the landscape in general). For positive judgements, 23% of the codes concern the glacier, rising to 55% for negative judgements.

4.1.4 Sadness as the main emotion

Different emotions were identified through the tourists' interviews: enchantment, surprise, shock, sadness, and happiness. However, sadness was the main emotion for 50% of the people

interviewed. This feeling was almost exclusively linked to the idea of ‘loss’ of an emblematic object (i.e. the glacier) or of an experience that would not be renewable (for example, past experiences of skiing down the Vallée Blanche). For many, sadness was also linked to the impossibility of passing down this landscape, considered as ‘heritage’, to their children; ‘I have seen it, but for my children, what?’ said a respondent.

4.2 Quantitative results

4.2.1 Descriptive statistics

The average age of the respondents to the survey questionnaire was 43 years (range 18–80 years), 60% (N = 432) were first-time tourists to Montenvers. Among the respondents, 54% (N = 418) lived in France, and 46% were foreigners (Table 4). Concerning the landscape, 94% (N = 429) of the respondents acknowledged that the beauty of the landscape met their expectations (answered ‘yes’ or ‘maybe yes’ to this question), and 96.5% (N = 170) of respondents who revisit. However, among them, 54.2% (N = 165) considered the landscape to be as beautiful as the last time, 34.3% considered it to be a little less beautiful, and 9.6% as much less beautiful. To the question ‘would you have come if it were no longer possible to see the glacier?’ 18.5% (N = 432) answered ‘probably no’ and 11.7% responded ‘no’; thus, in total, 30.2% of the respondents answered this question negatively.

4.2.2 Linear regression analysis

The results of the multiple linear regression show that the analysis significantly predicts landscape dissatisfaction ($F= 6.59$; $p < 0.001$) and explains 21% of its variance ($R^2= 0.21$; $\text{ajd. } R^2= 0.18$). Collinearity tests show that all predictors have a variance inflation factor (VIF) coefficient of <10 and a tolerance of >0.3 , which are acceptable for rejecting multicollinearity problems (Field, 2005).

The model indicates that environmental motivation is significant at $p < 0.001$ in predicting landscape dissatisfaction and indicated that high environmental motivation leads to low dissatisfaction. Estimation of the retreat rate of the Mer de Glace, willingness to visit the site if the glacier is not visible from the viewpoint, living in France or abroad, and mountaineering or hiking practice predicted landscape dissatisfaction at $p < 0.01$. This indicates that the lesser the respondents are dissatisfied, the more they will consider that the disappearance of the glacier is remote in time and the more they would be willing to visit the site even if the glacier was not visible. However, respondents living in France seem to be more dissatisfied than respondents living abroad. Finally, respondents who practice less mountaineering and hiking were less dissatisfied. Age range and storytelling motivation were significant at $p < 0.05$ and indicated that younger respondents and those who have a low storytelling motivation and stated a low willingness to tell others about the trip were more dissatisfied. It must be noted that nature connectedness is insignificant at $p = 0.051$, but the error margin suggests that this variable could have been significant with a larger sample size; this could indicate that the more the respondents consider themselves to be close to nature, the lesser they are dissatisfied with the landscape (Table 5).

5. Discussion

5.1 Explanations for landscape dissatisfaction and aesthetic judgement

Quantitative analysis shows that tourist characteristics can explain their dissatisfaction. Environmental motivation is a significant driving element for tourists to visit this particular place (Salim & Ravanel, 2020) and other glacier tourism destinations (Lemieux et al., 2018; Stewart et al., 2016), negatively correlate to landscape dissatisfaction. The relation between motivation and dissatisfaction is consistent with other studies, which show that the naturalness of the glacier area is an important factor for satisfaction (Groulx et al., 2016; Weber et al., 2019) and that natural landscapes often received positive judgement (Purcell et al., 1994; Zube et al., 1982). The correlation

between storytelling motivation and dissatisfaction is also significant. This could simply be because dissatisfied tourists are less likely to tell others about their visits (Cater et al., 2020). Respondents living abroad displayed lower dissatisfaction than respondents living in France. This may be because the Mer de Glace is the best-known French glacier, and it is frequently used by the media to illustrate climate change (Salim & Ravanel, 2020). French-living tourists, who know more about this glacier, would therefore be less 'surprised' by the landscape and have a less 'extraordinary' experience than foreigners who know much less about the glacier before their visit. However, quantitative analysis remains limited, and the regression analysis explains only 21% of the variance in terms of landscape dissatisfaction.

Qualitative results allow for the identification of dimensions that result in negative or positive judgements. Among the categories developed, a sense of identity seems to be related to the concept of place attachment. As it has a positive effect on the attractiveness of natural landscapes (Kaltenborn & Bjerke, 2002), place attachment could be an explanatory factor for the satisfaction of the glacial landscape. Other categories were also similar to those developed by Kirillova et al. (2014): rarity, questions of scale (referred to as sublime in this study), diversity and novelty, the 'untouched' character or its opposite. However, these categories do not have the same weight, and some are very widely represented as glacier changes, debris, and nature degradation among the negative categories. This corresponds to observations at other sites, where changes in volume and debris cover are often the elements that induce tourists to form a negative judgement of the glacial landscape (Moreau, 2010) or a shift between what is expected and what is seen (Stewart et al., 2016). Conversely, the three most represented positive categories are sublime, wilderness, and naturalness. Naturalness seems to be important at other sites too (Weber et al., 2019). Fear, a part of wilderness, can be perceived positively (Heimisdóttir et al., 2019), and the elements of sublime are often perceived positively in other contexts (e.g., Beza, 2010; Breiby, 2014; Nepal & Chipeniuk, 2005).

These categories provide a better understanding of the elements that influence tourists' judgement of the landscape, and they can provide useful information for managers.

5.2 Does the climate-impacted landscape lead to negative judgements from tourists?

Proglacial forms are little known to tourists and are often considered inaesthetic (Moreau, 2010). Additionally, cognitive aesthetics indicates that the knowledge of objects influences the judgement of their aesthetic value (Carlson, 2007). The results of the qualitative survey support the assumption that proglacial forms are negatively perceived since several concrete elements leading to respondents' negative judgements of the landscape are related to various elements of pro- or paraglacial origin, such as the destabilisation of moraines or debris. However, the quantitative analysis does not substantiate that the negative judgement is due to a lack of knowledge of these forms. Contrastingly, the statistical analysis showed a positive relationship between the practice of mountaineering and hiking and dissatisfaction with the landscape, suggesting that tourists who practice more are more dissatisfied with the landscape. According to qualitative results, this may be explained by the identity-related category of negative judgements: people who practice more have a stronger relationship with the place and are more likely to perceive changes negatively. This contradicts studies (for example, see Ramkissoon et al., 2013) showing a positive relationship between place attachment and satisfaction. Nonetheless, in our study, climate change induced changes to the place that respondents perceived negatively. Thus, the stronger the place identity, the more these changes lead to dissatisfaction. Furthermore, the linear regression showed that the more the tourists estimate the retreat rate of the glacier in line with the current projection (Peyaud et al., 2020), the more they were dissatisfied with the landscape. This result supports the hypothesis that in the case of a destination where the main element (the glacier in this study) is negatively affected by an event (climate change in this study), a strong attachment to the place would imply a decrease in satisfaction. Further research could test the hypothesis that climate change and the 'destruction' it

brings to certain places could lead to a negative relationship between place attachment and satisfaction among tourists.

Changes to the glacier lead to negative judgements from tourists. In other studies, glacier changes lead to a gap between what tourists expect and what they see and this was established in their expectation to see a bigger or whiter glacier (Stewart et al., 2016). This is also reflected in the Canadian survey that assessed tourists' preferences for future landscapes, where preference is given to the largest glacier (Groulx et al., 2016). However, while changes in the glacier (in length and volume) are the most frequently cited negative elements, the landscape in the qualitative survey is perceived positively for various reasons that are often detached from the glacier. Thus, even if the glacier is largely judged negatively, the landscape, in general, is still judged positively. The quantitative results support this claim, with 94% of the respondents stating that the landscape they see corresponds to what they expected (answered 'yes' or 'maybe yes' to this question). This is in line with other studies showing that dissatisfaction remains low in the glacier tourism context (Stewart et al., 2016) and other outdoor recreation contexts (Roemer & Vaske, 2014).

5.3 Is the attractiveness of glacial tourism sites threatened?

The results of surveys carried out on other glacial sites have established the importance of the glacier for some destinations (e.g., Stewart et al., 2016; Welling et al., 2020; Yuan et al., 2006). Our results suggest that up to 30.2% of the respondents would not have visited the site if the glacier was not visible; the disappearance has been predicted to occur within the next 30 years (Peyaud et al., 2020). Accordingly, stakeholders must prepare for this significant change. The regression analysis showed that landscape dissatisfaction reduced visitors' intention to visit the site if the glacier was not visible. Considering that satisfaction is related to tourists' expectations (Oliver, 1980), managers have the opportunity to rethink their marketing strategies to reduce the importance of the glacier and limit the risk of negative disconfirmation. Efforts are already partially underway since managers have begun

to reposition by marketing historical aspects of the site (Piai & Salim, 2020). To transition, and following Welling et al. (2020), the extensive use of glaciers to educate tourists about the environmental issues that they represent can be used by sites. This is especially significant as visiting such a destination may increase tourists' pro-environmental behaviour (Miller et al., 2020). Furthermore, He & Hinch (2021) showed that climate change interpretation elements can positively impact tourist satisfaction in the case of glacier tourism. Finally, since the 'natural' and 'wild' characteristics of the site are important elements in the respondents' judgements, managers must be cautious about developing new infrastructures that might be negatively perceived (Weber et al., 2019; Welling et al., 2020).

6. Conclusions

This study investigated tourists' judgements of the glacial scenic landscape at the Montanvers-Mer de Glace, the largest glacier in the French Alps. The results of the quantitative and qualitative surveys showed that tourists still consider the landscape to meet their expectations despite considerable changes in the glacier. However, more than two-thirds of the respondents in the qualitative survey reported negative judgements mainly related to glacial, pro-, or paraglacial elements such as the retreat of the glacier or the debris on its surface. Conversely, respondents' positive judgements were often linked to the landscape in a more global way or to the elements such as summits and vegetation. The quantitative survey shows that environmental motivation, estimation of glacier retreat rate, and tourist characteristics influence their judgements. These results need to be confirmed in future studies. Based on the observed landscape, the study revealed 17 categories that are abstract and on a large scale; these explain the elements leading to respondents' judgements of the glacial landscape. Although dissatisfaction with the landscape remains low, questions regarding the potential decrease in the number of tourists at the site when the glacier disappears in about 30 years arise. The results lead us to consider whether the site will remain attractive to visitors for its

spectacular scenery even without glaciers. However, managers should prepare tourists for a world without ice by gradually reducing the importance of the glacier in marketing and repositioning themselves around other values such as history, natural environment, and the emblematic character of the site. This last point can be immediately established by relying on the fact that Montanvers-Mer-de-Glace is emblematic of the consequences of climate change. Strengthening the elements of climate change interpretation could increase tourist satisfaction, lead them to understand the effects and processes linked to climate change better and ultimately increase their intention to mitigate it. From this perspective, glacier tourism could become a formidable tool for environmental education and a catalyst for action.

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Figure

Figure 1. The Mer de Glace; a) synthetic map of the Montanvers site; b) the “Glaciorium” museum; c) main viewpoint on the glacier; d) in the ice cave.

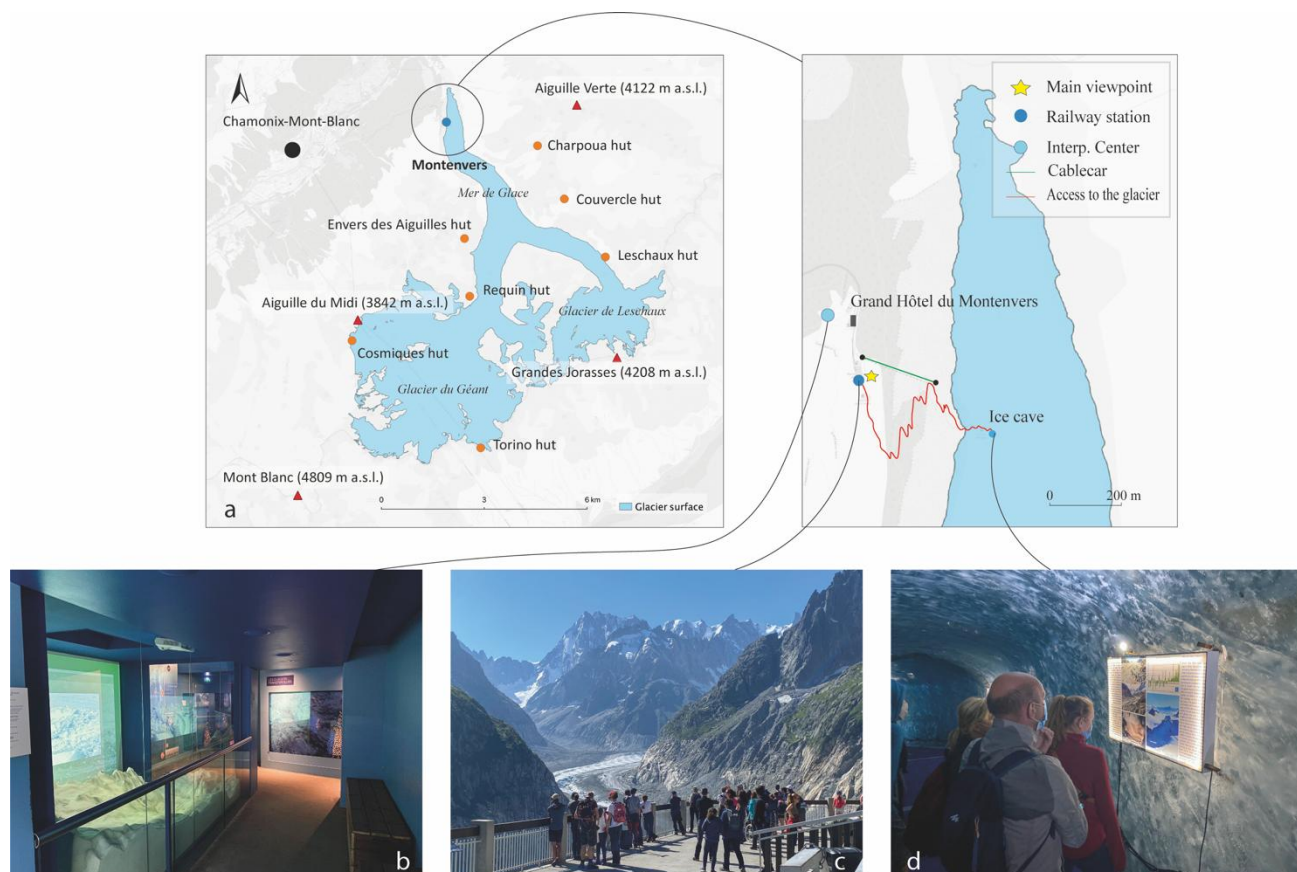


Figure 2. The Montenvers; a) Montenvers railway station in 1919 (coll. Gay-Couttet) and b) in 2020.



Table

Table 1. Summary of codes and categories

In a separate file – see : <https://doi.org/10.1016/j.jort.2021.100411>

Table 2. Positive categories and associated quotes

Categories	Quote	Occurrence
Sublime	"We in terms of the landscape, here what impressed me, like yesterday at the Aiguilles du Midi, we are very high, and then in fact we look up and there are even more."	26
	"Yeah, this big, this vast... knowing that, knowing that there is a hell of a distance from there to there. So, yeah, there's this great big desert out there... You can see that greatness so far already."	
Wilderness	"I have the impression that we can't go everywhere, and nature also obliges us not to go to every place. Well, there are some places there, it's impracticable because it's dangerous, and it's also beautiful to see that."	17
	There is no life, finally the human being is not there, we don't see houses, we don't see factories, we don't see cars. It is also its wild side.	
Naturalness	"That's the wild side. We're not going to say that it hasn't moved, but it's the side where the men stopped, then it's nature."	14
	"After that, we look at the desert, there is no life, there is no human being, we see no houses, we see no factories, we see no cars. It's also its wild side that is beautiful."	
Hedonism	"I find [the landscape] fills me with... I feel peaceful when I see it."	14
	"Yes, it's a haven of peace here, I feel rested when I see this [landscape]."	
Humility	"But we're small, and I have the impression that we can't go everywhere, and nature also forces us not to go to every place, it's impractical because it's dangerous, because that's it, and it's also beautiful to see that."	8
	"It's beautiful, it takes you away, it shows us how small we are."	
Rarity	"It's splendid, it's something we're not used to seeing except in pictures."	7
	"My first impression is wow. Really personally I've never seen that before, so, wow."	
Changes	"We're going upstairs to see the change. It's beautiful and then it's like we come to see something else. We're in the same place, but every year it's not quite the same."	5
	"I thought it was good to see the glacier, when the glacier was up to that level, in that year. And I knew that it melting, but I didn't know it was so fast or so much in so little time. So it's impressive, I'm impressive then."	
Reflexivity	"I think we're in, like, one of those places that leads to kids talking to each other. We're three generations. It's a place, unlike the seaside, where we go to places, uh... for holidays or landscapes where I don't think we have that kind of thinking. I think that this glacier is a reflection that we've been thinking about since this morning when we knew we were going to come here."	4

Identity "That makes me think we have some nice places in France. I think that we often try to go abroad and finally our France is beautiful and we have to preserve it. That's what I think when I look at this. I'm thinking that we don't need to spend hours and hours on the plane to see such a beautiful landscape. It's good that everyone knows it and that we preserve our environment." 4

"Seeing this landscape, as a Frenchman, I limit myself to my country. I'm proud when I see all this for myself. I tell myself it's ours."

Table 3. Negative categories and associated quotes

Categories	Quote	Occurrence
Glacier changes	<p>"I saw all these rocks, I thought we were talking about the glacier, but in the end, I couldn't see. I was looking to see if I could see some ice, so you can see things there. We're far away, we'd be very small if we were down there, but Mer de Glace is, I think it's more rocky than icy."</p> <p>"I didn't expect that, I still expected to see more ice, because I didn't expect that it would also mark the melting of the glaciers, all that emptiness."</p>	52
Debris cover	<p>"Yeah, you can only see rock and then you can see some of it, it's sandy from a distance like that, sandy and all. The ice is hard to see because it's covered by rocks."</p> <p>"There are rocks everywhere, it looks more like a construction site than a glacier. It's a bit like mining a quarry."</p>	29
Nature degradation	<p>"It's just not natural anymore. It's not natural. It's like... it's like you can see the human footprint has passed."</p> <p>"It's unnatural, it's catastrophic, it's like you can feel the degradation of nature here."</p>	28
Drought	<p>"I thought it was a little more icy, more ice, more white, but it's with the change that it's actually too hot."</p> <p>"After of course it meanders like that, I could almost imagine a river that's dry, you know? That's it!"</p>	12
Identity	<p>"I practising this inspires me with insecurity already. At the level, afterwards it is the mountain that decomposes. [...] There are a lot of courses that used to be done in the summer, snow courses, that you don't do any more."</p> <p>"We can't accept that our childhood landscapes that we knew and loved, our own children won't see them, it upsets me."</p>	8
Reflexivity	<p>"For me it's important to see, to realise what's going on. When you see the pictures of the past and you come here today, you can see that there is a big problem ..."</p> <p>"It made me think of the construction of the Suez Canal. And then it reminded me of a dark future."</p>	6
Desolation	<p>"It's desolation. When you see it fifty years ago and now there is nothing."</p>	2

"It's a dead landscape. It's sad what, to see that. It's nicer to see it with big ice, though. Like in the old photos, it's prettier what."

Attractivness "I won't go to the Mer de Glace any more, this hole doesn't make sense anymore. It's a heap of ebouli." 2

Table 4. Demographic and visitation characteristics

Demographic	Categories	Sample <i>N</i> = 434
<i>Sex</i>		<i>N</i> = 433
	Female	219 (50.6%)
	Male	214 (49.4%)
<i>Age</i>		<i>N</i> = 433
	Range	18-80
	18 to 25	52 (12.0%)
	26 to 35	112 (25.9%)
	36 to 45	90 (20.8%)
	46 to 55	84 (19.4%)
	56 to 65	60 (13.8%)
	More than 65	35 (8.1%)
	Median	41
<i>Country of residence</i>		<i>N</i> = 418
	France	226 (54.1%)
	Other	186 (45.9%)
<i>Living...</i>		<i>N</i> = 431
	In a town or its periphery	256 (59.4%)
	In the countryside	175 (40.6%)
<i>First visit</i>		<i>N</i> = 432
	Yes	260 (60.2%)
	No	172 (39.8%)
<i>Mountain visit</i>		<i>N</i> = 432
	Almost never	20 (4.6%)
	Rarely	49 (11.3%)
	From time to time	143 (32.9%)
	Often	113 (26%)
	Very often	86 (19.8%)
	I live there	21 (4.8%)
<i>Trip lenght</i>		<i>N</i> = 430
	One day or less	125 (29.1%)
	1 to 2 nights	75 (17.4%)
	3 to 5 nights	87 (20.2%)
	5 to 7 nights	92 (21.4%)
	More than 7 nights	51 (11.9%)
<i>“Does the beauty of the landscape meet your expectation?”</i>		<i>N</i> = 429
	Yes	282 (65.0%)
	Maybe yes	123 (28.3%)
	Maybe no	20 (4.6%)
	No	4 (0.9%)

Table 5. Results of the regression analysis

Model (N = 364)	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
(Constant)	3,465	0,451		7,683	0,000		
Environment factor	0,242	0,062	0,228	3,901	0,000*	0,662	1,511
LCT factor	0,094	0,065	0,093	1,440	0,151	0,537	1,862
Learning factor	-0,065	0,060	-0,066	-1,074	0,284	0,605	1,652
Tranquility factor	0,053	0,063	0,044	0,833	0,405	0,815	1,227
Story Telling factor	0,149	0,063	0,132	2,360	0,019***	0,720	1,390
CC-P	-0,061	0,085	-0,041	-0,724	0,469	0,704	1,420
Nature Relatedness	0,133	0,068	0,107	1,960	0,051	0,759	1,318
Do you often go to the mountains? (0=No; 1=Yes)	-0,151	0,127	-0,060	-1,187	0,236	0,888	1,127
Do you often practice hiking or mountaineering? (0=No; 1=Yes)	-0,332	0,100	-0,174	-3,314	0,001**	0,824	1,214
In your opinion, in how many years the Mer de Glace will disappear?	0,100	0,037	0,140	2,726	0,007**	0,851	1,175
First visit (0=Non; 1=Yes)	0,151	0,099	0,078	1,521	0,129	0,849	1,178
Age Range	0,075	0,034	0,114	2,197	0,028***	0,841	1,189
What is your country of residence? (1=France; 2= Other)	0,260	0,097	0,139	2,677	0,008**	0,841	1,189
Would you have come if it was no longer possible to see the glacier?	0,097	0,035	0,142	2,795	0,005**	0,877	1,140
R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson	F	Sig.	
,457 ^a	0,209	0,177	0,84940	1,847	6,591	,000 ^b	

a. Dependent Variable: Does the beauty of the landscape meet your expectations (1=No; 4= Yes) - * p < 0.001; ** p < 0.01; *** p < 0.05